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# PSYCHOLOGICAL MEASUREMENTS DURING THE WEAR OF THE US AIRCREW CHEMICAL DEFENSE ENSEMBLE

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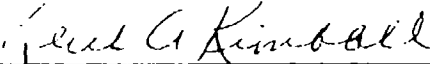
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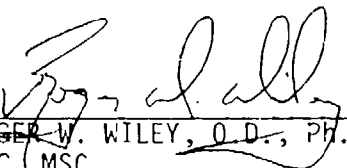
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20. Abstract:

The psychological (as opposed to physiological) effects of wearing a US aircrew chemical defense ensemble were evaluated using 12 male and 12 female volunteers. Half of the males and half of the females wore chemical defense ensembles while the rest wore standard US flight suits as controls. All subjects were administered tests of cognition (math, logical reasoning, target detection, and reaction time) before and after 5 hours of wear in a controlled environment. In addition, subjects rated their mood before and after wear. It was concluded that wearing the ensemble in an undemanding environment degraded affect (mood and activation levels), slightly decreased accuracy, and substantially decreased reaction times, especially in females. The most serious impact of the ensemble would seem to be a decrease in morale among females.

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# TABLE OF CONTENTS

	PAGE NO.
List of Illustrations . . . . .	4
List of Tables . . . . .	4
Introduction . . . . .	5
Method . . . . .	5
Subjects . . . . .	5
Apparatus . . . . .	6
Procedure . . . . .	6
Results . . . . .	9
Physiological/Environmental . . . . .	9
Mood . . . . .	9
Cognitive . . . . .	12
Discussion . . . . .	20
Conclusions . . . . .	23
References . . . . .	24
Appendixes	
Appendix A - Volunteer Consent Forms . . . . .	27
Appendix B - List of Companies and Brand Names . . . . .	35
Appendix C - Individual Mood Data . . . . .	36
Appendix D - Individual Data (Standard Flight Suit) . . . . .	37
Appendix E - Individual Data (US CD Ensemble) . . . . .	43



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## LIST OF ILLUSTRATIONS

FIGURE	PAGE NO.
1. Ensembles Worn During Testing . . . . .	7
2. Subjects During Testing . . . . .	7
3. Temperature and Heart Rate Monitoring Instrumentation . . . . .	8
4. Subject Wearing US Chemical Defense Ensemble Taking Computerized Psychological Test . . . . .	8
5. Means and Standard Deviations for Serial Math Test . . . . .	13
6. Means and Standard Deviations for Target Detection Test . . . . .	15
7. Means and Standard Deviations for Logical Reasoning Test . . . . .	17
8. Means and Standard Deviations for Reaction Time Test . . . . .	19

## LIST OF TABLES

TABLE	PAGE NO.
1. Summary of WBGT and Physiological Measures for Subjects Wearing US CD Ensemble . . . . .	10
2. Summary of Mood and Activation Percent Changes . . . . .	11
3. Percent Change in Serial Math Attributed to US CD Ensemble . . . . .	14
4. Percent Change in Target Detection Attributed to US CD Ensemble . . . . .	16
5. Percent Change in Logical Reasoning Attributed to US CD Ensemble . . . . .	18
6. Percent Change in Reaction Time Attributed to US CD Ensemble . . . . .	20
7. Ranking of Tests According to Sensitivity . . . . .	22

## INTRODUCTION

Recent world events have changed the belief that chemical/biological agents will not be used in future battles (cf., Haig, 1982). As a result, comprehensive training while in full chemical defense (CD) ensembles (Mission Oriented Protective Posture (MOPP) IV, FM 21-40) is now underway. This is especially true in Army aviation as Aircrew Training Manuals (TC 1-135, TC 1-136, TC 1-137, and TC 1-139) make MOPP IV training mandatory. Most research into performance while wearing the United States (US) CD ensemble has concentrated on performance degradations caused by the physiological impact of the associated heat stress (Goldman and others, 1981; Garrett and DeBellis, 1981; and Myhre, 1981). The psychological effects of wearing a CD ensemble (as opposed to the associated heat stress) have not previously been reported.

CD ensembles can influence psychological function indirectly, as in the case of heat stress, or directly by means of psychological stressors, such as claustrophobia. The effect of heat stress on aviators in CD ensembles has been studied (Hamilton, Simmons, and Kimball, 1982) with the result that the cognitive changes noted in the laboratory (cf., Poulton, 1976 and Wing, 1965) have been shown to occur in the aviation setting. In addition, disruptions in subjects' speed of reaction and quality of response were described. However, any effects due to the ensembles themselves were confounded by the effects of the physiological stressor, heat. This study was undertaken to provide a baseline estimate of the psychological effects of wearing the US aircrew CD ensemble in the absence of other stressors.

## METHOD

### SUBJECTS

The subjects were 12 male and 12 female US Army enlisted personnel who had volunteered to participate after attending unit briefings on the study. Ages ranged from 18 to 30 years with a mean of 25 for the males and 23 for the females. All subjects were in good physical condition and had participated in MOPP IV training previously. In accordance with US Army Medical Research and Development Command Regulation 70-25 (27 April 1981), subjects were briefed on the nature, purpose, and hazards of the experiment and had signed informed consent forms (Appendix A) prior to participation.

## APPARATUS

Testing was conducted in the US Army Aeromedical Research Laboratory (USAARL), Biomedical Applications Research Division. Subjects donned standard US flight suits upon reporting for testing. The US Aircrew CD ensemble used in this study was worn over the flight suit (NSN 8415-00-491-0925) and consisted of the M-24 aircrew protective mask (NSN 240-00-776-4334), the SPH-4 aircrew helmet (NSN 8415-144-4981), the M-7 chemical protective hood (NSN 4240-00-021-8695), the US chemical protective suit (NSN 8415-00-177-5008), butyl rubber gloves (NSN 8415-01-033-33519), and butyl rubber foot covers (NSN 8430-01-021-5978) worn over standard combat boots. Heart rate monitoring was accomplished using Quinton\* stress electrodes and a Tektronix\* 414 monitor. Skin and rectal temperature measurements were accomplished using a Digitec\* 5800 electronic thermometer and Yellow Springs, Inc.\* (YSI) 709A and YSI 701R temperature sensors. Computerized psychological testing was done using an Apple II Plus\* microcomputer with disk drive and remote terminal capability.

## PROCEDURE

### General

Subjects reported to USAARL at 0800 hour on their scheduled test day and donned a standard US flight suit (Figure 1, A, p. 7). Half of the subjects then donned the US aircrew CD ensemble over the flight suit (Figure 1, B, p. 7). Subjects were free to relax, watch television, play video games, read, or interact with experimenters (Figure 2, p. 7). Water was available at hourly intervals throughout the test period. At the end of 6 hours, subjects changed back into their original clothes and were released. Males and females were tested on separate days.

### Physiological Data Collection

Subjects wearing the US aircrew D ensemble had heart rate and temperature measurements (see above for equipment list) taken at 30-minute intervals commencing immediately prior to donning the CD ensemble. Temperatures consisted of left bicep, left upper chest, left thigh, and left calf (Figure 3, p. 8). The first four subjects had core temperature monitored via rectal thermometers as a heat-safety precaution. Percent of body fat was determined by conversion of girth measurements (Wright, Dotson, and Davis, 1980 and 1981).

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\*Appendix B contains a list of brand names and addresses for all commercially available equipment used in this report.

FIGURE 1. Ensembles Worn During Testing. A--Standard US flight suit, B--aircrew chemical defense ensemble with temperature telemetry.



FIGURE 2. Subjects During Testing.

### Psychological Data Collection

Psychological testing was conducted after donning the standard flight suit (prior to donning the US CD ensemble where appropriate) and at the end of the 6-hour test period (Figure 4). Testing was conducted utilizing subtests of the Psychological Assessment Battery (PAB) developed by the Walter Reed Army Institute of Research, Division of Neuropsychiatry. The subtests used were the mood scale, logical reasoning, serial math, target detection, and four-choice reaction time. This test battery is described in detail by Hamilton, Simmons, and Kimball (1982).



FIGURE 3. Temperature and Heart Rate Monitoring Instrumentation.



FIGURE 4. Subject Wearing US Chemical Defense Ensemble Taking Computerized Psychological Test.

## RESULTS

### PHYSIOLOGICAL/ENVIRONMENTAL

Physiological data from subjects wearing US CD ensembles and general environmental data are summarized in Table 1 (p. 10). Wet Bulb/Globe Temperature (WBGT) overall was 19.8°C at the beginning of the test period and 22.2°C at the end. Mean WBGT temperatures for the males were 20.2°C at the beginning and 20.8°C at the end, whereas the means for the females were 19.4°C and 23.5°C. The females experienced a greater range of environmental temperatures; and with only one exception, ambient WBGT for females was higher than any of those experienced by the males.

Mean skin temperature was computed using the formula

$$T_m = .3T_1 + .3T_2 + .2T_3 + .2T_4$$

where  $T_1$  = upper arm temperature,  $T_2$  = chest temperature,  $T_3$  = thigh temperature, and  $T_4$  = calf temperature (Livingston, Rud, Brooks, and Bowen, 1981). Mean skin temperatures of males and females combined were 33.9°C at the beginning of the test period and 35.4°C at the end of the period. Mean skin temperatures for the males were 34.6°C at the beginning and 35.6°C at the end, a difference of 1.0°C. Mean skin temperatures for females were 33.3°C at the beginning and 35.2°C at the end, a difference of 1.9°C. Mean rectal temperatures for the four subjects monitored were 37.7°C at the beginning and 37.4°C at the end, a decrease of .3°C. Mean rectal temperatures for the two males were 37.5°C at the beginning and end of the test period while mean rectal temperatures for the females were 37.8°C at the beginning and 37.3°C at the end, a decrease of .5°C.

Mean combined male and female heart rates were 78.6 beats per minute (BPM) at the beginning and 75.7 BPM at the end. Mean male heart rates were 78.7 BPM at the beginning and 76.7 BPM at the end. Mean female heart rates were 78.5 BPM at the beginning and 74.7 BPM at the end of the test period. Although subjects had water available at hourly intervals, only one subject wearing the US CD ensemble drank any water and then only once.

### MOOD

Subjects were asked to complete a 65-item mood scale at the beginning and end of the test period. Each mood item received a 1 to 5 rating from the subject as to his/her degree of agreement with the mood descriptor. Mood scale items were scored and grouped into one of two categories, mood or activation. Mood referred to a composite score of anxiety, hostility, and depressive feelings while activation referred to the subject's perceived

feeling of arousal and vigor. Since some of the items concerned the "positive" aspects of the grouping (such as happy) and some the "negative" aspects (such as unhappy), a composite score was computed which ranged from -4 (most extreme negative) to +4 (most extreme positive). Composite mood and activation scores for each group of subjects tested are found in Appendix C.

TABLE 1  
SUMMARY OF WBGT AND PHYSIOLOGICAL MEASURES FOR SUBJECTS  
WEARING US CD ENSEMBLE

SUBJECT	SKIN PRE	SKIN POST	RECTAL PRE	RECTAL POST	HEART PRE	HEART POST	WBGT PRE	WBGT POST	% FAT
M1E	34.1	35.5	37.6	37.5	75	82	21.4	20.7	15.4
M2E	35.8	36.0	37.5	37.5	70	52	21.7	20.3	9.0
M3E	33.0	34.6	*	*	78	81	16.7	21.7	29.9
M4E	34.3	35.1	*	*	84	89	21.7	21.8	16.2
M5E	35.0	35.8	*	*	66	51	19.1	19.4	*
M6E	35.3	35.3	*	*	89	87	21.7	20.8	19.7
F1E	34.3	35.1	37.5	37.6	72	70	15.2	24.9	31.1
F2E	34.7	36.4	*	*	76	79	16.2	22.5	21.1
F3E	30.2	35.2	33.0	37.6	80	78	19.7	21.0	24.6
F4E	33.5	34.2	*	*	85	73	17.8	23.2	*
F5E	33.4	35.8	*	*	87	80	20.1	24.8	*
F6E	33.3	37.1	*	*	67	63	20.1	24.8	24.4
MEANS									
MALE	34.6	35.6	37.5	37.5	78.7	76.7	20.2	20.8	18.0
FEMALE	33.3	35.2	37.5	37.3	78.5	74.7	19.4	23.5	25.3
BOTH	33.9	35.4	37.7	37.4	78.6	75.7	19.8	22.2	21.3

NOTE: Temperatures are in °C, heart rates in beats per minute. Subjects whose identifier starts with an "M" were males, those with "F" were females.

\*Not recorded.

In order to clarify the effect upon mood engendered by the test period, the difference between the pretest and posttest percent of change scores was computed for a number of distinct groups and is presented in Table 2. The groups compared were male, female, standard flight suit, and US CD ensemble. In addition, scores were grouped according to those subjects tested when the WBGT was below 24°C and those tested when above 24°C WBGT. The "difference" row

in the table presents the difference between the score for the US CD ensemble and the standard flight suit. This is intended to be an indication of the degree of change related to the wear of the US CD ensemble, since the control subjects in standard flight suits experienced the same time-of-day effects and environmental conditions as the experimental subjects.

TABLE 2  
SUMMARY OF MOOD AND ACTIVATION PERCENT CHANGES

MOOD					
SUIT	OVERALL	MALE	FEMALE	<24°C	>24°C
Standard	-4.72	-7.22	-2.22	-5.33	-3.00
US CD	-6.48	-1.67	-11.33	1.00	28.89
Difference	-1.76	5.55	-9.11	6.33	31.89
ACTIVATION					
Standard	.09	2.78	.22	.78	-2.56
US CD	-4.90	-.78	-9.11	-2.00	-13.67
Difference	-4.99	-3.56	-9.33	-2.78	-11.11

As can be seen in Table 2, little overall difference in mood was documented since the standard flight suit produced a 4.72% decrement in mood, while the US CD ensemble produced a 6.48% decrement with a difference of 1.76% attributed to the US ensemble. However, a different picture emerges when considering the male and female groupings within ensembles. Males experienced a 7.22% decrease in mood in the standard flight suit while only a 1.67% decrement was seen when wearing the US CD ensemble. Thus, mood in males wearing the US ensemble did not worsen as in the standard flight suit but instead improved since the difference score was a positive 5.55%. The female group, on the other hand, experienced a difference score of -9.11% in mood attributed to the US CD ensemble. The difference between the male and female response to the US CD ensemble then was 14.66% (male difference score minus female difference score) in mood with the females experiencing decrements.

When the data were grouped into those whose ambient WBGT was less than 24°C and those in excess of 24°C, then a more pronounced difference of -25.56% occurs between the temperature groups. In this case, the less than 24°C WBGT group demonstrated a protection against mood decrement. Examination of

physiological data in Table 1 revealed that the only subjects tested in ambient temperatures in excess of 24°C WBGT were females. The activation data presented in Table 2 does not evidence the same kind of protective effect seen in the mood data since activation decreased overall by 4.99%. Males decreased their activation levels by 3.56% and females by 9.33% for a difference between male and female activation scores of 5.77%. The difference between male and female activation scores was not as pronounced as in mood, but females again showed more decrease than males.

The less than and more than 24°C WBGT groups also exhibited a difference in activation, but not as pronounced as in mood. The hotter WBGT group did, however, exhibit considerably more decrement in activation level than in mood.

## COGNITIVE

The cognitive data from the tests were scored in two ways. The first way converted pretest and posttest scores into percent of change scores using the formula  $((A-B)/B) \times 100$  where A = the posttest score and B = the pretest score. This presented individual scores on a plus or minus scale with negative numbers indicating decreases in score relative to the pretest and positive numbers indicating increases. The second way of scoring the data was in terms of percent attributable to the US CD ensemble. This was computed by subtracting the control data from the experimental data. For example, the percent attributed to the US CD ensemble for males would be the mean of the differences between the scores for the males in the US CD ensembles and the males tested on the same day but wearing the standard flight suit. Preliminary analysis of the data revealed that some subjects had rather large percent of change scores. These subjects started with low percent correct scores but finished with much higher scores; some had changes of up to 200%. This was assumed to indicate a learning effect. Therefore, the data from subjects whose percent of change score exceeded 50% were eliminated for that test. The cutoff of 50% was selected because it was twice the maximum change seen during an equivalent testing period by Hamilton et al. (1982). Individual data for the group wearing the standard flight suit are available in Appendix D. Individual data for subjects wearing the US CD ensemble are available in Appendix E.

### Serial Math

The means and standard deviations for the four subject groups (males wearing standard flight suits, males wearing US CD ensembles, females wearing standard flight suits, females wearing US CD ensembles) are shown in Figure 5. As can be seen, the standard deviations of the mean scores were large and the effect upon mean percent of change relatively small in comparison. Table 3 (p. 14) presents the mean percent of change scores for number attempted, percent correct, reaction time to correct (RTcor), and reaction time to error (RTerr) for a number of comparisons. Males wearing the US CD ensemble showed a 2.25% decrease in the mean number of problems attempted. The accuracy with which the males worked decreased by 11.75%. RTcor decreased by 6.08%

indicating a slight speed up in the rate at which they worked the problems. RTerr showed a 25.23% increase, indicating a lengthening of the time spent deliberating problems which were eventually answered incorrectly. The trade-off between increased speed when correct and decreased speed when incorrect resulted in the slight decrease seen in the number attempted. Females, on the other hand, showed less of a drop (1.90%) in number attempted and increased accuracy (7.08%). RTcorr decreased by 17.68% while RTerr increased by 30.63%.

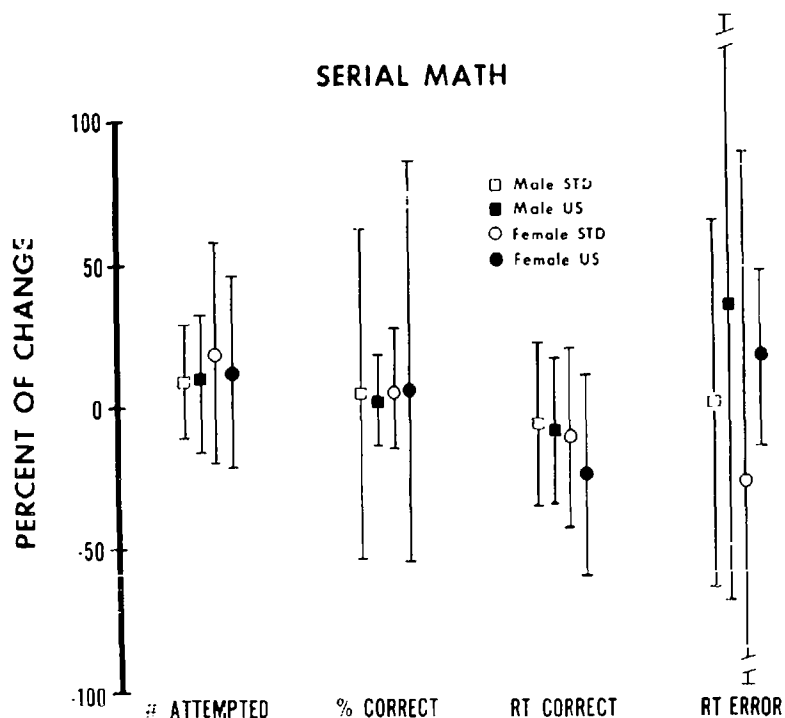


FIGURE 5. Means and Standard Deviations for Serial Math Test. Open symbols are for subjects wearing standard US flight suits (STD) while filled are for subjects wearing US chemical defense ensembles (US). Brackets indicate range of standard deviation.

The effect of WBGT less than 24°C upon number attempted was negligible (-0.7%). Accuracy decreased by 6.33% with RTcorr also decreasing by 12.78% (indicating faster reaction times). RTerr, however, increased by 25.23%. This is in contrast to the scores of those whose WBGT was in excess of 24°C. This group demonstrated an 8.10% decrease in number attempted and a 9.65% increase in accuracy. RTcorr decreased by 9.15% while RTerr increased by 30.63%. Scores for the females and greater than 24°C WBGT group were similar since the greater than 24°C WBGT group was a subset of the female group. Overall, a 2.08% decrease in number attempted, a 2.34% decrease in accuracy, an 11.88% increase in speed (decrease in reaction times), and a 27.39% decrease in speed of incorrectly worked problems was associated with the wearing of the CD ensemble. A two-factor ANOVA (Edwards, 1960) was conducted

to compare the factors of ensemble and sex. The only measure which was statistically significant was RTcor ( $p=.01$ ).

TABLE 3  
PERCENT CHANGE IN SERIAL MATH ATTRIBUTED TO US CD ENSEMBLE

GROUP	# ATTEMPTED	% CORRECT	RTcor	RTerr
Male	-2.25	-11.75	-6.08	25.23
Female	-1.90	7.08	-17.68	30.63
<24°C WBGT	-.07	-6.33	-12.78	25.23
>24°C WBGT	-8.10	9.65	-9.15	30.63
Overall	-2.08	-2.34	-11.88	27.39

PERCENT CHANGE IN SUBGROUPS

US (Males)	7.75	1.73	-9.35	33.67
US (Females)	12.03	15.08	-25.20	15.53
US (<24°C WBGT)	6.55	4.53	-15.40	22.20
US (>24°C WBGT)	19.90	20.00	-22.90	3.30
US (Overall)	9.89	8.40	-17.28	16.80
STD (Males)	8.70	4.23	-6.48	-.31
STD (Females)	18.61	5.41	-12.07	-28.82
STD (<24°C WBGT)	7.32	5.84	-5.17	6.62
STD (>24°C WBGT)	32.67	6.77	-9.35	-30.89
STD (Overall)	13.66	4.83	-9.25	-3.61

RT = reaction time  
US = US CD ensemble  
STD = standard flight suit

#### Target Detection

As in the previous test, standard deviations were large, although in comparison to the previous tests, somewhat reduced (Figure 6). The data presented in Table 4 (p. 16) summarize the results of the target detection test. Males in the US CD ensemble attempted 9.84% more problems than controls in standard flight suits. Their accuracy decreased 15.48% and RTcor decreased 11.62%. Thus, they were working faster and attempting more, but were less accurate. Computation of RTerr was not possible due to 100% accuracy in pretests. Females increased the number attempted by an amount similar to males (9.50%) but increased accuracy by 5.88%. RTcor decreased by 13.71% which was comparable to the males.

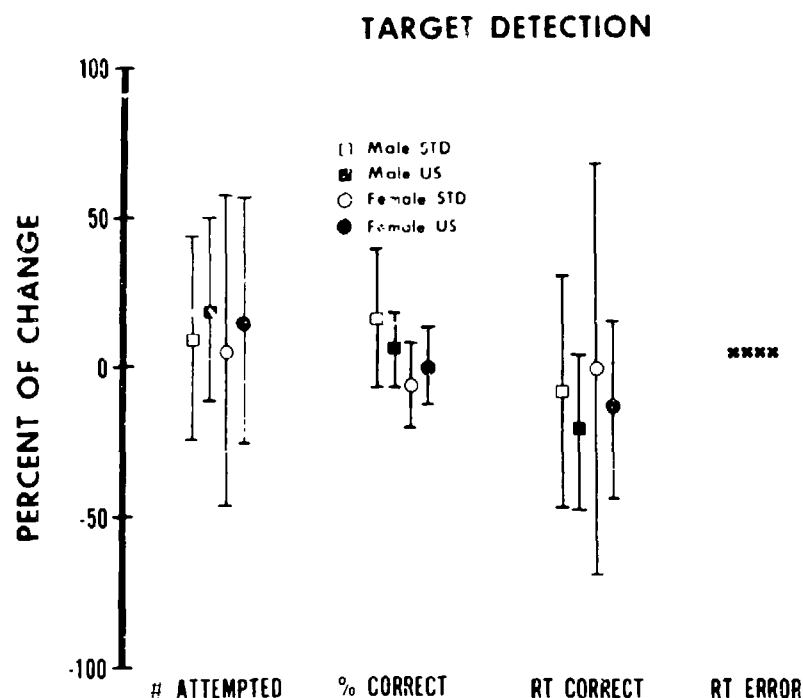


FIGURE 6. Means and Standard Deviations for Target Detection Test. Open symbols are for subjects wearing standard US flight suits (STD) while filled are for subjects wearing US chemical defense ensembles (US). Brackets indicate range of standard deviation. \*\*\*\* = not computable.

The group wearing the ensemble in ambient temperatures below 24°C WBGT also increased the number attempted (17.53%) and decreased accuracy by 7.55%. Their RTcor decreased by 21.41%. All of these changes were in the same direction as the male group; however, subjects in the greater than 24°C WBGT group decreased their number attempted by 11.33%, increased their percent correct by 6.10%, and increased their RTcor by 10.31%. These changes were in the opposite direction than the less than 24°C WBGT group and for the most part the opposite of the male and female groups. Overall there was a 9.65% increase in the number attempted, a 3.83% decrease in accuracy, and a 12.76% decrease in RTcor attributed to the US CD ensemble. ANOVA was also conducted on this data with significant differences being noted for sex ( $p=.01$ ) and an ensemble by sex interaction ( $p=.05$ ).

TABLE 4

## PERCENT CHANGE IN TARGET DETECTION ATTRIBUTED TO US CD ENSEMBLE

GROUP	# ATTEMPTED	% CORRECT	RTcor	RTerr
Male	9.84	-15.43	-11.62	-
Female	9.50	5.88	-13.71	-
<24°C WBGT	17.53	-7.55	-21.41	-
>24°C WBGT	-11.33	6.10	10.31	-
Overall	9.65	-3.83	-12.76	-

## PERCENT CHANGE IN SUBGROUPS

US (Males)	23.62	2.22	-23.78	-
US (Females)	15.33	.55	-13.71	-
US (<24°C WBGT)	22.63	1.48	-21.54	-
US (>24°C WBGT)	10.00	1.10	-10.35	-
US (Overall)	19.48	-7.19	-18.75	-
STD (Males)	9.70	16.40	-2.32	-
STD (Females)	5.83	-5.33	.00	-
STD (<24°C WBGT)	2.44	8.13	2.55	-
STD (>24°C WBGT)	21.30	-5.00	-20.60	-
STD (Overall)	7.59	4.55	-3.78	-

RT = reaction time

US = US CD ensemble

STD = standard flight suit

Logical Reasoning

The means and standard deviations for the various groups are presented for the logical reasoning test in Figure 7. A wide range of variability was seen in the data as exemplified by percent correct data for the females in the US CD ensemble and the males in the standard flight suit. Table 5 (p.18) presents the percent of change in posttest scores attributed to the US CD ensemble. Males wearing the ensemble experienced a 13.5% increase in the number of problems attempted while increasing their percent correct by 2.21%. RTcor decreased by 8.48% and RTerr increased by 65.50%. Females increased the number attempted by 39.00% with a 1.50% increase in accuracy. RTcor for females decreased by 52.85%. Due to training effects, RTerr was not available for females.

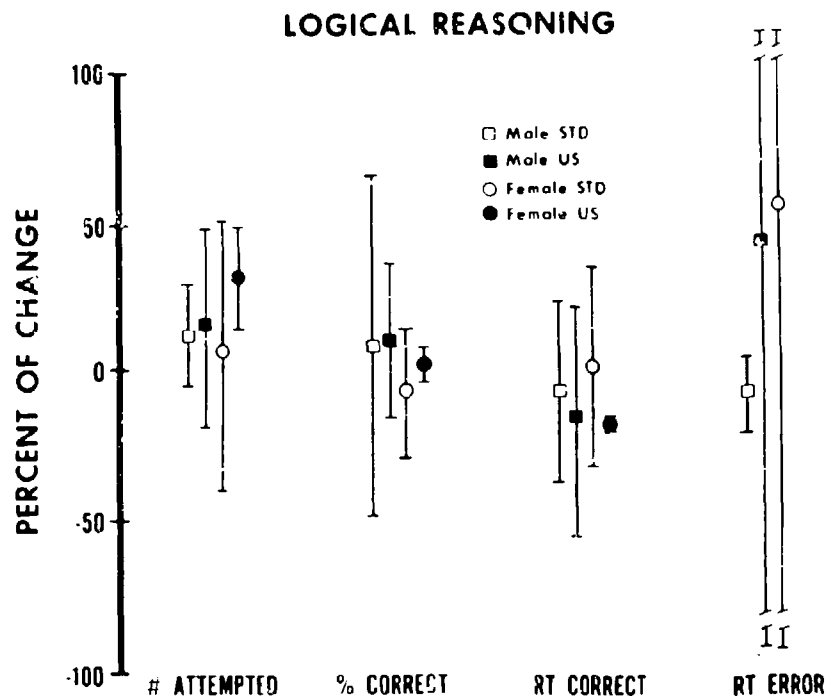


FIGURE 7. Means and Standard Deviations for Logical Reasoning Test. Open symbols are for subjects wearing standard US flight suits (STD), while filled are for subjects wearing US chemical defense ensembles (US). Brackets indicate range of standard deviation.

The group whose ambient WBGT was less than 24°C demonstrated a 21.60% increase in number attempted. Because this group is composed of the male group with females added, the effect of adding the females was to raise the mean percent of change score for number attempted which indicated that males and females did not score similarly in identical environmental conditions.

Percent correct for those tested in the cooler WBGT increased by 5.57%, while RTcor decreased by 12.12%. The greater than 24°C WBGT group showed an increase in number attempted (24.00%) which was similar to the less than 24°C WBGT group, but the groups differed on the remaining measures. Percent correct decreased by 16.00% with RTcor decreasing by 42.00%. The difference then in percent correct between the two temperature groups was 21.57 percentage points while RTcor differed by 30.68 percentage points. The over 24°C WBGT group was working considerably faster while making considerably more errors. Overall the number attempted increased by 22%, accuracy increased by 1.97%, and RTcor decreased by 23.27%. The only measure which proved significant by ANOVA was RTcor for ensemble ( $p=.01$ ).

TABLE 5

## PERCENT CHANGE IN LOGICAL REASONING ATTRIBUTED TO US CD ENSEMBLE

GROUP	# ATTEMPTED	% CORRECT	RTcor	RTcor
Male	13.50	2.21	-8.48	65.50
Female	39.00	1.50	-52.85	-
<24°C WBGT	21.60	5.57	-12.12	65.50
>24°C WBGT	24.00	-16.00	-42.80	-
Overall	22.00	1.97	-23.27	65.50

## PERCENT CHANGE IN SUBGROUPS

US (Males)	17.44	10.05	-17.20	43.80
US (Females)	39.67	-10.77	-33.33	35.10
US (<24°C WBGT)	22.31	7.84	-19.57	35.60
US (>24°C WBGT)	50.00	-37.00	-49.00	-44.57
US (Overall)	25.78	2.24	-23.25	25.25
STD (Males)	10.84	8.74	-7.42	-7.98
STD (Females)	5.63	-7.55	.63	152.67
STD (<24°C WBGT)	2.81	5.43	1.20	.30
STD (>24°C WBGT)	28.52	-12.25	-13.10	120.60
STD (Overall)	8.52	1.50	-3.84	60.57

RT = reaction time

US = US CD ensemble

STD = standard flight suit

Reaction Time

For the most part, mean scores in the reaction time test did not differ across groups (Figure 8). Standard deviations were generally lower than in the tests discussed above. Standard deviations were small for percent correct with the exception of females wearing the US CD ensemble. Table 6 (p. 20) presents the percent change attributed to the US CD ensemble for the reaction time test. The change in number attempted among males wearing the US CD ensemble was a decrease of 4.02% over pretests. The percent correct decreased by 0.31% with RTcor increasing 6.36%. Thus, males attempted fewer trials with a longer reaction time while maintaining accuracy. RTerr, however, decreased by 12.58% over pretests. On the other hand, females increased the number attempted by 1.83% and decreased their accuracy by 8.55%. RTcor decreased by 2.23% and RTerr decreased by 2.60%. Thus, females attempted more with less accuracy while decreasing their reaction time. Instead of an 18.80% difference between RTcor and RTerr as in males, there was only a 0.37% difference between the measures in the females. Thus, males and females reacted to the stress of

wearing the ensembles differently in terms of psychomotor reaction time. The same general differences existed between those tested in ambient temperatures less than and greater than 24°C WBGT.

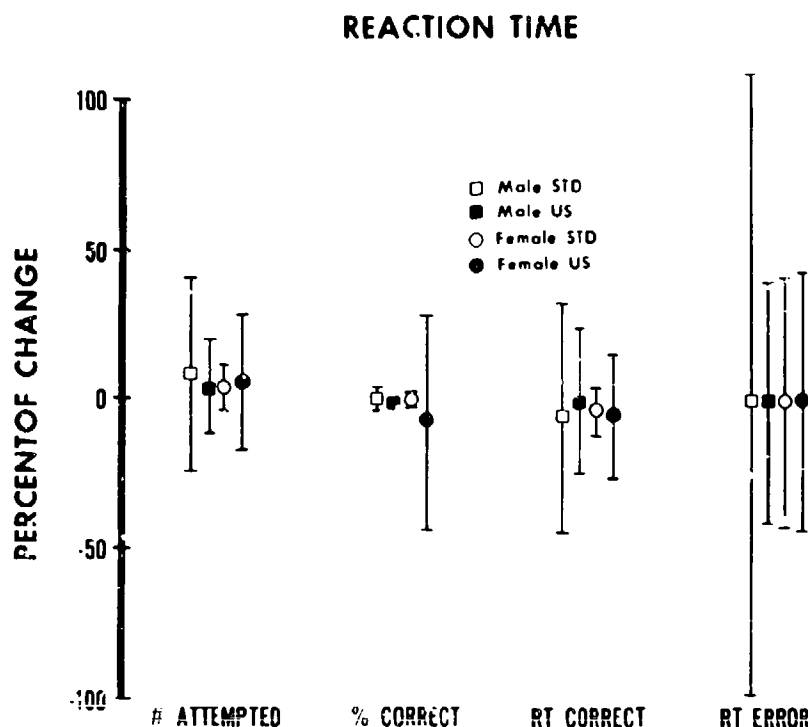


FIGURE 8. Means and Standard Deviations for Reaction Time Test. Open symbols are for subjects wearing standard US flight suits (STD), while filled are for subjects wearing US chemical defense ensembles (US). Brackets indicate range of standard deviation.

Number attempted in the less than 24°C WBGT group decreased by 4.73%, percent correct decreased by 0.60%, with RTcorr increasing by 4.56%, and RTerr decreasing by 11.70%. As was the case in the females, the greater than 24°C WBGT group showed a 9.17% increase in number attempted, a 15.93% decrease in accuracy, and 5.43% and 3.20% decreases in RTcorr and RTerr respectively. The net result of moving half of the female data in with the male data to form the two temperature groups was to make the difference between the new groups larger than for the male and female groups. The differences in results were greater between the temperature groups than between the male/female groups. The overall result of wearing the US CD ensemble was a 1.10% decrease in number of trials attempted, a 4.43% decrease in accuracy, a 2.07% increase in RTcorr, and a 2.76% decrease in RTerr. None of the measures proved to be statistically significant by means of the two-way ANOVA.

TABLE 6

## PERCENT CHANGE IN REACTION TIME ATTRIBUTED TO US CD ENSEMBLE

GROUP	# ATTEMPTED	% CORRECT	RTcor	RTerr
Male	-4.02	-.31	6.36	-12.58
Female	1.83	-8.55	-2.23	-2.60
<24° WBGT	-4.73	-.60	4.56	-11.70
>24° WBGT	9.17	-15.93	-5.43	-3.20
Overall	-1.10	-4.43	2.07	-2.76

## PERCENT CHANGE IN SUBGROUPS

US (Males)	3.70	-.70	-1.50	-.74
US (Females)	5.75	-8.01	-6.31	-.60
US (<24°C WBGT)	2.65	-.58	-2.98	-2.84
US (>24°C WBGT)	10.93	-15.70	-6.70	3.00
US (Overall)	4.73	-4.36	-3.91	-1.17
STD (Males)	8.05	.15	-6.80	-1.70
STD (Females)	3.91	.54	-4.85	-1.55
STD (<24°C WBGT)	7.39	.38	-6.80	-3.50
STD (>24°C WBGT)	1.77	.23	-1.20	6.20
STD (Overall)	5.98	.34	-5.83	-1.63

RT = reaction time

US = US CD ensemble

STD = standard flight suit

## DISCUSSION

The independent variable in this experiment was the wear of the US CD ensemble. Subjects did not perform manual labor, nor were they subjected to heat stress; therefore, the intervention must be considered minimal. The only important uncontrolled variables were ambient temperature variations and the lack of structured activity for the subjects. This latter variable will be discussed below.

The major experimental question was whether or not the wearing of the US CD ensemble had a measurable impact under the conditions tested. The overall answer to this question is that in terms of subject's affect (mood and activation) there was some change, while in terms of cognitive function (accuracy and reaction time) there was substantial change, primarily in reaction time.

Changes in affect did not exceed 5.00% attributable to the US CD ensemble, while cognitive changes attributed to wearing the ensemble ranged upwards of 4.50% (accuracy) and 23.27% (reaction time). Overall, wear of the US CD ensemble was judged not to have seriously changed affect while slightly decreasing accuracy and substantially increasing the speed at which subjects worked. This effect is consistent with the known ability of slight stress to stimulate performance (Poulton, 1976). The subjects were, on the whole, stimulated to work faster with a concomitant slight increase in errors while wearing the US CD ensemble, regardless of sex or ambient temperature.

A second question to be addressed is whether or not males and females reacted differently to wearing the ensemble. Within this context, the US CD ensemble resulted in a difference in mood levels between males and females of 14.66% with females having lower mood levels. The reported activity levels among females was 5.77% less than among males. Cognitive function of males in the US CD ensemble ranged from 21.36% worse (accuracy) to 61.33% better (reaction time) than females. For the most part, male affect was less susceptible to change than female, but male accuracy of work was prone to greater decrements. Most tests showed that male reaction times were slowed relative to females by wearing the US CD ensemble, but one test (logical reasoning) showed marked increases in speed (paired with slight increases in accuracy). Males and females reacted differently in the US CD ensemble with the nature and extent of change dependent upon the test.

Since some subjects were tested in ambient temperatures less than 24°C WBGT, comparison of these temperature-different groups was made. The subjects wearing the US CD ensemble and tested in the greater than 24°C WBGT had reported mood levels that were 32.22% less than those similarly dressed and in the less than 24°C WBGT ambient temperature. Similarly, activation was 8.33% less in the subjects tested in the higher temperature. Despite these drops in affect, accuracy was up to 26.80% better in the higher ambient temperatures. Reaction times varied, with some tests showing a 31.77% increase in speeds, some showing a 30.58% decrease, and some no real change. Ambient temperature was, therefore, considered to influence both mood and performance.

The discussion presented above alluded to the various tests used in this study as reflecting different responses and sensitivity to the US CD ensemble. The results indicate that the various tests measure different aspects of cognitive function, each aspect differentially sensitive to the stress. Consequently, tests were ranked in order of those with the most absolute degree of change to least degree of change for the various categories discussed (Table 7). Logical reasoning appeared as most sensitive more often than any other followed by target detection. Reaction time and serial math appeared equally sensitive, with math showing a greater degree of change. This ranking could be explained by considering the degree of cognition required in the tests. For instance, logical reasoning can be presumed to require more cognition than target detection.

TABLE 7  
RANKING OF TESTS ACCORDING TO SENSITIVITY

ACCURACY			REACTION TIME		
ENSEMBLE	SEX	TEMPERATURE	ENSEMBLE	SEX	TEMPERATURE
Reaction Time	Target Detect	Logical Reason	Logical Reason	Logical Reason	Target Detect
Target Detect	Serial Math	Serial Math	Target Detect	Serial Math	Logical Reason
Serial Math	Reaction Time	Reaction Time	Serial Math	Reaction Time	Reaction Time
Logical Reason	Logical Reason	Target Detect	Reaction Time	Target Detect	Serial Math

Ranking of test sensitivity from most (top) to least (bottom). Categories are ensemble (US CD ensemble vs standard flight suit), sex (males wearing US CD ensemble vs females wearing US CD ensembles), and temperature (US CD ensemble worn when temperature was above and below 24°C WBGT).

Three problems existed with this study. The first was the lack of statistical reliability which can be placed on these differences. Only a few measures from a few tests were shown by a two-factor ANOVA (Edwards, 1960) comparing ensemble worn with sex to be significant. These were target detection accuracy for sex ( $p=.01$ ) and ensemble by sex interaction ( $p=.05$ ), logical reasoning RTcor for ensemble ( $p=.01$ ), and serial math RTcor for ensemble ( $p=.05$ ). The reason for lack of statistical confirmation is clear when the sizes of the standard deviations are compared (cf. Figures 5-8). The reason for this variability may be sampling error (no treatment effect) or a range effect inherent in the type of testing being performed. By this is meant that a ceiling and floor effect may prevent the range of change in mean scores from being sufficient to prevent overlap. It is unlikely that subjects would show marked decrements in cognitive ability and would not change much in response to such marginal intervention as used in this study. Reaction times, which could conceivably change a great deal, did show relatively larger changes and were statistically significant across ensembles in half of the occasions.

A second difficulty in the study was the fact that only females experienced ambient WBGT temperatures in excess of 24°C. Since differences between male and female subjects were seen, the data from the over 24°C WBGT group

could be biased. Some data, as mentioned in the result section, argue that this might not be the case, while other data argue in favor of bias. Also, the final skin temperatures as noted in Table 1 indicate that the mean physiological response of the females was different from the males (cf. percent body fat, Table 1). Further work will be required to resolve whether or not temperatures in excess of 24°C WBGT (but less than 25°C WBGT) systematically affects cognition.

The third difficulty was that subjects were not stimulated by their environment during testing. Subjects were free to amuse themselves during testing by watching TV, playing video games, reading, or sleeping. This was a deliberate decision when the experiment was designed, but leaves the study open to the criticism that boredom lowered performance. Giving the subjects structured tasks would have resolved the problem of boredom, but the interaction of the tasks and ensemble would then have become confounding variables.

### CONCLUSIONS

In summary, wearing the US CD ensemble in a benign, undemanding environment lowered mood and activation levels in females while mood was raised and activation declined in males. Accuracy and reaction times decreased slightly, especially in females. Since accuracy did not degrade substantially and the effect of the ensemble was to decrease reaction times, it was concluded that the US CD ensemble does not, in and of itself, cause serious impairment of cognitive function (accuracy and reaction time), but morale (mood and activation levels) may decrease, just by the wear of the ensemble. Temperature considerations are clearly of critical importance when predicting cognitive performance and mood when wearing CD ensembles.

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APPENDIX A

VOLUNTEER CONSENT FORMS

## VOLUNTEER PARTICIPATION AGREEMENT

I, \_\_\_\_\_, SSN \_\_\_\_\_, having attained my eighteenth (18th) birthday, and otherwise having full capacity to consent, do hereby volunteer to participate in a research study entitled: "Physiological Assessment of the Aircrew Chemical Defense Clothing," under the direction of the US Army Aeromedical Research Laboratory.

The implications of my voluntary participation; the nature, duration, and purpose; the methods and means by which it is to be conducted; and the inconveniences and hazards which may reasonably be expected have been explained to me by Bruce E. Hamilton, Ph.D., Principal Investigator, and are set forth on the attachment of this Agreement, which I have initialed. I have been given an opportunity to ask questions concerning this investigational study, and my questions have been answered to my full and complete satisfaction.

I understand that I may at any time during the course of this study revoke my consent and withdraw from the study without prejudice. However, I may be required to undergo further medical examinations, if in the opinion of the attending physician such examinations are necessary for my health or well-being.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

I was present during the explanation referred to above as well as the Volunteer's opportunity for questions and hereby witness his signature.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

## VOLUNTEER AGREEMENT (ATTACHMENT)

### PURPOSE

You are being asked to participate in a research program entitled: "Physiological Assessment of the Aircrew Chemical Defense Clothing," to assess the biomedical and physiological feasibility of using the United Kingdom (UK) Aircrew Chemical Defense (CD) Ensemble in the US Army aviation environment. Prior to your participating in the study, you will be given a physical examination by a flight surgeon and will be asked to fill out a medical history questionnaire.

### PROCEDURE

You will be asked to don and wear for 6 hours either the US Chemical Defense Ensemble or a standard US Nomex Flight Suit. During this period you will be asked to take a psychomotor test battery three times. At no time will you be asked to leave the USAARL building, nor will you be asked to perform any demanding physical labor. You will be free to watch television, read, or engage in a variety of computer-generated video games. You will be monitored by investigators at all times. You will be connected to physiological monitoring equipment via skin surface electrodes and a flexible rectal temperature probe and your medical vital signs monitored at regular intervals.

### RISKS

The medical risks associated with this project are that of heat-related injuries; i.e., heat exhaustion, heat stroke, and heat pyrexia. An explanation of these injuries follows:

#### Heat Exhaustion

This disorder can be broken down into two areas: a water-deficient heat exhaustion or dehydration and salt-deficient heat exhaustion.

#### Water-Deficient Heat Exhaustion

It is an effect of excessive exposure to heat and becoming water-depleted due to inadequate replacement of water losses caused by prolonged sweating. Signs and symptoms: thirst, fatigue, giddiness, oliguria, pyrexia, and in advanced stages, delirium and death.

#### Salt-Deficient Heat Exhaustion

It is an effect of excessive exposure to heat in which salt depletion occurs due to inadequate replacement of salt lost through prolonged sweating.

Signs and symptoms: fatigue, nausea, vomiting, giddiness, muscle cramps, and in late stages, circulatory failure.

### Prevention and Treatment

Prevention of heat exhaustion requires an adequate supply of water easily accessible while working in hot climates or conditions both during and after working hours. The treatment consists essentially of rest in bed in a cool environment with a high intake of fluids. The preferable method of intake is by mouth unless the person is unconscious, then fluid replacement needs to be given intravenously. Also, the person should be kept cool until his thermoregulatory system is back in balance.

### Heatstroke

A state of thermoregulatory failure with sudden onset following exposure to a hot environment with a high body temperature  $> 40.6^{\circ}\text{C}$  ( $105^{\circ}\text{F}$ ) characterized by an absence of sweating and disturbance of the central nervous system. It is frequently fatal.

### Hyperpyrexia

The same symptoms as a heatstroke except the patient is conscious and may be sweating. The rectal temperature will be slightly lower than that of heatstroke. Signs and symptoms: euphoria, headache, dizziness, drowsiness, numbness, restlessness, purposeless movements, incoordinated movements, aggressiveness, mania, suicidal tendencies, mental confusion, and sudden onset of delirium or coma in heatstroke.

The following are some definitions of some terms which we have used above with which you may not be familiar:

Oliguria - Secretion of a diminished amount of urine in relation to the fluid intake.

Pyrexia - A fever, or a febrile condition; abnormal elevation of the body temperature.

Psychomotor - Pertaining to motor effects of cerebral or psychic activity.

Cognitive Functioning (Cognition) - The operation of the mind by which we become aware of objects of thought or perception, including understanding and reasoning.

Mania - Excitement manifested by mental and physical hyperactivity, disorganization of behavior, and elevation of mood.

You will be stressed and uncomfortable during this study, but we have established safety limits and the experiment will not be allowed to proceed if any of these limits are reached. By monitoring your heart rate, respiration,

skin and rectal temperature and comparing these parameters with established limits, we will be able to terminate the experiment at a point which will minimize the risk to you.

\_\_\_\_\_  
Initials

\_\_\_\_\_  
Date

## HEALTH AND SAFETY STANDARD OPERATING PROCEDURE

1. The experiment will be terminated under the following conditions:
  - a. Subject desires termination.
  - b. Investigator observes deterioration in mental ability or performance of the subject.
  - c. Rectal core temperature in excess of  $38.9\frac{1}{2}^{\circ}\text{C}$ .
  - d. Rectal core temperature and skin temperature converge to within .5C and/or, these temperatures rapidly converge.
2. The decision to terminate will be made by any or all of the following personnel:
  - a. Subject.
  - b. Investigator.
  - c. Flight surgeon.
3. The subject will unzip the protective clothing and remove the protective mask. If the subject requires assistance, the investigator will assist.
4. If the session is terminated because of medical condition, the following actions will be taken:
  - a. Flight surgeon will be notified immediately.
  - b. CD ensemble will be stripped from subject and fluids given if possible.
  - c. If necessary, CPR will commence.
5. The flight surgeon will evaluate the medical condition of the subject pilot (vital signs to be taken) and direct appropriate therapeutic measures to be undertaken.

### For Heat Cramps:

- a. Fluid replacement orally with water will be attempted.
- b. Vital signs will be carefully monitored.
- c. If symptoms continue, an IV of Normal Saline will be started by the flight surgeon, to run at 150 cc/hr or as indicated by condition of subject.
- d. Upon stabilization, the subject will be transported to Lyster Army Hospital for observation.

### For Heat Exhaustion:

- a. Subject will be taken to cool area and cold compresses will be applied to forehead.
- b. Vital signs will be carefully monitored.
- c. Remaining treatment will be as for heat cramps (see above).

For Heat Pyrexia:

- a. Most of subject's clothing will be removed.
- b. Subject will be immersed in an ice water bath. The bath will be discontinued when the rectal temperature falls below 38.3°C (101¼F). Treatment will be resumed if a febrile rebound occurs.
- c. An IV of Normal Saline will be started by the flight surgeon, to run at 150 cc/hr or as indicated by condition of subject.

For Respiratory Arrest:

- a. An oral airway will be inserted, ventilation will be given via bag-valve-mask device attached to O<sub>2</sub> source.
- b. If respirations do not become spontaneous within several minutes, an endotracheal tube will be inserted by the flight surgeon. Ventilation will continue on 100% oxygen via the bag-valve-mask device. The respiratory therapist will be responsible for maintaining artificial respiration.

For Cardiac Arrest:

- a. Subject will be placed on a hard flat table.
- b. The flight surgeon will start an IV of Normal Saline, to run at 150 cc/hr or as indicated by conditions of subject. The respiratory therapist will initiate ventilation via the bag-valve-mask device attached to O<sub>2</sub> source. Simultaneously, monitoring electrodes will be applied, and external cardiac compressions commenced. A cardiopulmonary resuscitation individual will be responsible for cardiac compressions. Standard American Heart Association (CPR) procedures will be adhered to.
- c. Upon successful IV placement, the flight surgeon will intubate the patient and ventilation will be maintained through the endotracheal tube by the respiratory therapist.
- d. AEC will be taken ASAP after electrodes have been applied.
- e. Flight surgeon will direct all drug and electroshock therapy as is appropriate (ACLS certification needed).
- f. When the patient is stabilized, he will be taken to Lyster Army Hospital for further medical treatment and/or observation.



DEPARTMENT OF THE ARMY  
U. S. ARMY AEROMEDICAL RESEARCH LABORATORY  
FORT RUCKER, ALABAMA 36362

UNCONDITIONAL CONSENT FOR USE OF PICTURE AND SOUND

The United States Government is granted the right to use, to the extent and for the purpose it desires, any pictures (still, motion, those transmitted via TV or recorded on video tape or otherwise) and sounds (vocal, instrumental, or otherwise) whether used together or separately, taken or recorded by or on behalf of the Aeromedical Research Laboratory.

\_\_\_\_\_  
(DATE)

\_\_\_\_\_  
(SIGNATURE)

\_\_\_\_\_  
(HOME ADDRESS)

\_\_\_\_\_  
(MILITARY ADDRESS)

Above consent obtained by:

\_\_\_\_\_  
(SIGNATURE)

## APPENDIX B

### LIST OF COMPANIES AND BRAND NAMES

Apple II Computer, Inc.  
10260 Bandley Drive  
Cupertino, California 95014  
Apple II Plus 43K Microcomputer

Oxinton Instrument Company  
2121 Terry Avenue  
Seattle, Washington 97121  
Quinton Quik-Prep Stress Test Electrodes #11408-005

Tektronix  
Beaverton, Oregon 97005  
Tektronix 414 Heart Rate Monitor

United Systems Corporation  
Dayton, Ohio 45401  
Digitec 5800

Yellow Springs Instrument Co., Inc.  
Yellow Springs, Ohio 45387  
YSI 709A  
YSI 701R

APPENDIX C  
INDIVIDUAL MOOD DATA

INDIVIDUAL MOOD AND ACTIVATION SCORES

US CD ENSEMBLE					
MALE			FEMALE		
SUBJECT	MOOD	ACTIVATION	SUBJECT	MOOD	ACTIVATION
M1E (Pre)	-2.1	1.3	F1E (Pre)	-3.5	.1
(Post)	-1.9	.4	(Post)	-.8	-.9
M2E (Pre)	-2.8	.6	F2E (Pre)	-.6	.1
(Post)	-2.8	.6	(Post)	-2.1	-1.2
M3E (Pre)	-3.7	-.5	F3E (Pre)	-3.4	.2
(Post)	-3.9	.9	(Post)	-3.6	1.3
M4E (Pre)	-2.3	.3	F4E (Pre)	-1.8	.5
(Post)	-2.6	.4	(Post)	-1.8	-.5
M5E (Pre)	-3.6	.4	F5E (Pre)	-2.8	1.3
(Post)	-3.6	-.3	(Post)	1.0	.0
M6E (Pre)	-3.0	.3	F6E (Pre)	-3.8	1.0
(Post)	-1.8	-1.7	(Post)	-2.5	-.4
STANDARD FLIGHT SUIT					
M1C (Pre)	-3.2	1.4	F1C (Pre)	-2.5	.3
(Post)	-2.8	.8	(Post)	-2.9	.5
M2C (Pre)	-1.5	.4	F2C (Pre)	-1.8	.6
(Post)	-2.6	.0	(Post)	-2.3	.2
M3C (Pre)	-2.2	.3	F3C (Pre)	-3.0	-.1
(Post)	1.1	.3	(Post)	-2.8	.3
M4C (Pre)	-2.0	-2.2	F4C (Pre)	-2.7	.7
(Post)	-3.2	-.1	(Post)	-2.8	-.1
M5C (Pre)	-1.5	.6	F5C (Pre)	-3.5	.2
(Post)	-2.6	-.3	(Post)	-3.2	.1
M6C (Pre)	-2.1	.2	F6C (Pre)	-2.0	.2
(Post)	-2.5	.2	(Post)	-2.5	.2

Subjects whose identifier starts with an "M" were males, those with "F" were females.

APPENDIX D

INDIVIDUAL DATA (STANDARD FLIGHT SUIT)

# SERIAL MATH (STANDARD FLIGHT SUIT)

SUBJECT	# ATTEMPTED	% CORRECT	RTcor	RTerr
M1C (Pre)	33	60.6	2.69	6.16
(Post)	38	92.1	3.12	5.38
M2C (Pre)	41	87.8	2.90	2.50
(Post)	45	68.9	2.45	2.59
M3C (Pre)	32	68.3	3.20	6.28
(Post)	38	65.8	3.20	3.00
M4C (Pre)	40	77.5	3.07	2.37
(Post)	45	88.9	2.45	2.58
M5C (Pre)	32	87.5	4.89	3.34
(Post)	30	80.0	4.44	4.32
M6C (Pre)	39	74.4	2.67	4.23
(Post)	40	80.0	2.39	5.16
F1C (Pre)	26	92.3	4.81	11.79
(Post)	37	91.9	3.21	3.77
F2C (Pre)	27	92.6	5.20	5.63
(Post)	31	93.5	5.09	8.69
F3C (Pre)	44	97.7	2.57	4.32
(Post)	45	100.0	2.39	-
F4C (Pre)	40	80.0	2.91	3.34
(Post)	39	87.2	3.04	3.37
F5C (Pre)	28	96.4	4.89	54.46
(Post)	34	94.1	4.21	3.67
F6C (Pre)	17	52.9	5.50	13.34
(Post)	23	65.2	5.47	8.19

Subjects whose identifier starts with an "M" were males, those with "F" were females.

LOGICAL REASONING (STANDARD FLIGHT SUIT)

SUBJECT	# ATTEMPTED	% CORRECT	RTcor	RTerr
M1C (Pre)	31	93.5	5.44	5.14
(Post)	30	76.7	6.00	5.03
M2C (Pre)	7	14.3	4.91	17.92
(Post)	13	61.5	12.17	16.29
M3C (Pre)	33	39.4	4.53	5.29
(Post)	36	61.1	4.60	4.30
M4C (Pre)	36	86.1	4.29	6.10
(Post)	39	100.0	4.22	-
M5C (Pre)	23	69.6	7.48	7.52
(Post)	26	61.5	5.89	7.32
M6C (Pre)	18	72.2	10.29	8.05
(Post)	23	73.9	7.56	7.47
F1C (Pre)	32	93.8	4.82	10.01
(Post)	42	90.5	3.85	3.24
F2C (Pre)	16	100.0	11.11	-
(Post)	14	85.7	11.30	20.11
F3C (Pre)	27	92.6	5.90	10.90
(Post)	42	97.6	3.80	4.30
F4C (Pre)	40	95.0	4.01	3.11
(Post)	31	87.1	5.11	6.33
F5C (Pre)	15	73.3	11.06	13.60
(Post)	19	57.9	10.37	71.11
F6C (Pre)	13	46.2	18.28	9.77
(Post)	22	54.5	9.40	6.99

Subjects whose identifier starts with an "M" were males, those with "F" were females.

# TARGET DETECTION (STANDARD FLIGHT SUIT)

SUBJECT	# ATTEMPTED	% CORRECT	RTcor	RIerr
M1C (Pre)	16	100.0	5.62	-
(Post)	16	100.0	5.69	-
M2C (Pre)	8	87.5	14.88	5.22
(Post)	11	100.0	9.79	-
M3C (Pre)	3	33.3	-	37.50
(Post)	10	60.0	9.20	11.49
M4C (Pre)	15	80.0	5.88	6.57
(Post)	16	93.8	5.44	7.12
M5C (Pre)	8	75.0	14.42	11.26
(Post)	9	100.0	11.61	-
M6C (Pre)	13	84.6	7.33	87.32
(Post)	12	100.0	8.65	-
F1L (Pre)	13	92.3	7.51	8.08
(Post)	18	77.8	4.70	4.95
F2C (Pre)	12	100.0	8.02	-
(Post)	10	90.0	11.80	12.53
F3C (Pre)	13	100.0	7.40	-
(Post)	13	92.3	7.10	11.30
F4C (Pre)	15	100.0	6.10	-
(Post)	33	100.0	7.30	-
F5C (Pre)	14	73.3	17.14	13.60
(Post)	13	100.0	7.36	-
F6C (Pre)	12	46.2	18.28	9.77
(Post)	26	100.0	5.91	-

Subjects whose identifier starts with an "M" were males, those with "F" were females.

# REACTION TIME (STANDARD FLIGHT SUIT)

SUBJECT	# ATTEMPTED	% CORRECT	RTcor	RTerr
M1C (Pre)	718	99.9	.52	.49
(Post)	597	99.2	.65	1.04
M2C (Pre)	475	99.8	.87	2.78
(Post)	616	98.7	.63	.50
M3C (Pre)	565	97.0	.70	.68
(Post)	629	96.5	.62	.48
M4C (Pre)	608	99.5	.64	.54
(Post)	634	99.8	.61	.39
M5C (Pre)	546	94.7	.74	.59
(Post)	605	97.5	.65	.71
M6C (Pre)	704	97.3	.54	.43
(Post)	768	93.3	.48	.42
F1C (Pre)	766	99.1	.48	.42
(Post)	775	99.4	.47	.35
F2C (Pre)	704	98.2	.54	.43
(Post)	767	99.3	.48	.46
F3C (Pre)	654	99.1	.58	.65
(Post)	664	98.9	.57	.48
F4C (Pre)	595	97.3	.66	.58
(Post)	642	98.9	.60	.53
F5C (Pre)	692	99.4	.55	.35
(Post)	705	98.7	.54	.44
F6C (Pre)	738	97.4	.50	.46
(Post)	756	98.5	.48	.50

Subjects whose identifier starts with an "M" were male, those with "F" were females.

APPENDIX E

INDIVIDUAL DATA (US CD ENSEMBLE)

SERIAL MATH (US CD ENSEMBLE)

SUBJECT	# ATTEMPTED	% CORRECT	R1cor	RTerr
M1E (Pre)	63	98.4	1.27	.49
(Post)	65	96.9	1.19	1.04
M2E (Pre)	24	83.3	6.50	6.28
(Post)	26	100.0	5.51	-
M3E (Pre)	42	100.0	2.74	-
(Post)	45	95.6	2.38	4.00
M4E (Pre)	40	77.5	2.66	3.77
(Post)	51	90.2	1.94	2.61
M5E (Pre)	48	81.6	2.13	2.70
(Post)	45	86.7	2.31	3.21
M6E (Pre)	31	96.8	4.08	9.50
(Post)	49	85.7	1.93	3.44
F1E (Pre)	24	87.5	5.94	5.53
(Post)	46	41.3	1.64	2.84
F2E (Pre)	19	89.5	7.64	12.00
(Post)	29	100.0	4.63	-
F3E (Pre)	23	47.8	4.56	9.18
(Post)	21	61.9	3.38	12.86
F4E (Pre)	39	100.0	3.05	-
(Post)	46	91.3	2.13	4.18
F5E (Pre)	27	74.1	5.54	3.94
(Post)	37	54.1	2.85	3.87
F6E (Pre)	35	40.0	3.05	4.03
(Post)	36	66.7	3.12	4.37

Subjects whose identifier starts with an "M" were males, those with "F" were females.

# TARGET DETECTION (US CD ENSEMBLE)

SUBJECT	# ATTEMPTED	% CORRECT	RTcor	RTerr
M1E (Pre)	13	100.0	7.57	-
(Post)	14	100.0	6.73	-
M2E (Pre)	8	100.0	13.46	-
(Post)	10	100.0	10.27	-
M3E (Pre)	9	77.8	12.42	10.08
(Post)	13	84.6	7.07	9.44
M4E (Pre)	15	86.7	6.17	4.93
(Post)	17	100.0	5.01	-
M5E (Pre)	14	100.0	6.75	-
(Post)	15	93.3	6.15	5.19
M6E (Pre)	11	90.9	9.17	7.23
(Post)	16	87.5	5.68	5.08
F1E (Pre)	14	85.7	6.79	4.39
(Post)	14	85.7	6.82	4.30
F2E (Pre)	12	100.0	8.64	-
(Post)	12	100.0	8.36	-
F3E (Pre)	9	100.0	11.19	-
(Post)	13	100.0	8.24	-
F4E (Pre)	11	100.0	9.20	-
(Post)	13	100.0	7.14	-
F5E (Pre)	10	90.0	10.28	15.75
(Post)	13	100.0	7.22	-
F6E (Pre)	13	100.0	7.41	-
(Post)	13	92.3	7.22	6.22

Subjects whose identifier starts with an "M" were males, those with "F" were females.

LOGICAL REASONING (US CD ENSEMBLE)

SUBJECT	# ATTEMPTED	% CORRECT	RTcor	RTerr
M1E (Pre)	48	85.4	3.12	4.12
(Post)	45	93.3	3.48	3.52
M2E (Pre)	15	100.0	11.91	-
(Post)	24	100.0	7.03	-
M3E (Pre)	29	65.5	4.80	7.41
(Post)	40	87.5	4.10	3.48
M4E (Pre)	32	78.1	5.03	5.58
(Post)	37	83.8	4.30	5.45
M5E (Pre)	22	95.5	8.20	6.75
(Post)	27	96.3	5.83	22.97
M6E (Pre)	38	100.0	4.28	-
(Post)	62	98.4	2.41	2.64
F1E (Pre)	29	51.7	5.85	5.51
(Post)	62	58.1	2.70	1.94
F2E (Pre)	7	71.4	28.44	23.45
(Post)	4	75.0	86.80	53.88
F3E (Pre)	18	61.1	10.86	8.40
(Post)	23	60.9	8.03	6.58
F4E (Pre)	16	75.0	11.27	9.72
(Post)	31	90.3	5.37	6.39
F5E (Pre)	22	68.2	8.67	5.51
(Post)	33	42.4	4.39	5.36
F6E (Pre)	21	52.4	9.25	6.37
(Post)	73	49.3	1.78	2.08

Subjects whose identifier starts with an "M" were males, those with "F" were females.

# REACTION TIME (US CD ENSEMBLE)

SUBJECT	# ATTEMPTED	% CORRECT	RTcor	RTerr
M1E (Pre)	822	97.9	.44	.42
(Post)	842	96.0	.43	.35
M2E (Pre)	661	100.0	.51	-
(Post)	656	100.0	.59	-
M3E (Pre)	693	99.3	.55	.51
(Post)	665	98.5	.58	.48
M4E (Pre)	610	97.7	.64	.56
(Post)	721	98.5	.52	.33
M5E (Pre)	721	98.5	.52	.33
(Post)	725	98.6	.52	.44
M6E (Pre)	703	99.4	.54	.40
(Post)	815	98.8	.44	.37
F1E (Pre)	614	98.4	.64	.38
(Post)	767	57.4	.58	.33
F2E (Pre)	479	99.6	.85	1.19
(Post)	463	100.0	.89	-
F3E (Pre)	842	64.3	.50	.26
(Post)	866	63.2	.49	.26
F4E (Pre)	619	99.4	.63	.91
(Post)	633	99.7	.61	.56
F5E (Pre)	615	99.4	.64	.49
(Post)	682	93.3	.56	.52
F6E (Pre)	681	96.2	.56	.45
(Post)	667	93.4	.57	.52

Subjects whose identifier starts with an "M" were males, those with "F" were females.

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